CLAIMS

1. Automated method for discriminating the cardiac beat, on the basis of a blood pressure sampled signal, having a starting point Pstart, characterised in that it operates according to a finite state machine, comprising:

A. a first state (1), wherein the method searches for:

- the pressure absolute minimum value Pmin, by scanning the pressure values included within a first time interval not exceeding the interval going from the starting point Pstart up to the point distant from the determined minimum value Pmin by a first time threshold DTMIN_SYS,
- the pressure absolute maximum value Pmax, by scanning the pressure values included within a second time interval not exceeding the interval going from the starting point Pstart up to the point distant from the determined minimum value Pmin by a second time threshold DTMAX_SYS, and
- the pressure signal first derivative maximum value Y1max_postdia included within a third time threshold not exceeding the interval going from the starting point Pstart up to the point distant from the determined minimum value Pmin by a period equal to the second time threshold DTMAX_SYS,

the method assuming the point Pmin as diastolic point Pdia and the point Pmax as systolic point Psys, and passing to a following second state (2);

B. the second state (2), wherein the method searches for a pressure signal inflection point Pinflection following the systolic point Psys in a fifth time interval not exceeding the interval starting from the systolic point Psys and of duration equal to a third time threshold DTMAX_MINY1_SYS, the method then passing to a following third state (3);

C. the third state (3), wherein the method verifies whether, in a sixth time interval not exceeding the interval starting from the inflection point Pinflection and of duration equal to a fourth time threshold DTMAX_SYS2Y1DIC, the pressure signal presents a hump with downward concavity, so that:

- if the outcome of the verification is positive, the method searches, in a seventh time interval not exceeding the interval starting from the inflection point Pinflection and of duration equal to the fourth time threshold DTMAX_SYS2Y1DIC, for the first pressure curve relative minimum, and it assumes the latter as dicrotic point Pdic, whereas
- if the outcome of the verification is negative, the method searches in said seventh time interval the instant wherein the pressure signal second derivative assumes the maximum value Y2max_postinflection, and it assumes the related pressure signal point as dicrotic point Pdic,

the method then passing to a following fourth state (4);

D. the fourth state (4), wherein the method searches for a maximum

value Y1max_postdic of the pressure signal first derivative in an eighth interval not exceeding the interval starting from the dicrotic point Pdic and of duration equal to a fifth time threshold DPOSTDIC, the method verifying that the maximum value Y1max_postdia determined in the first state (1) is not less than the value Y1max_postdic, so that:

- if the outcome of the verification is negative, the method returns to the first state (1) assuming as new starting point Pstart a point following the diastolic point Pdia and not following the dicrotic point Pdic, whereas
- if the outcome of the verification is positive, the method passes to a final state (7); and

E. the final state (7), wherein the method is apt to give the diastolic point Pdia, the systolic point Psys, and the dicrotic point Pdic.

2. Method according to claim 1, characterised in that in the first state (1) it also searches for:

- the pressure signal second derivative maximum value Y2max_diatosys included within a fourth time interval not exceeding the interval going from the starting point Pstart up to the point distant from the determined minimum value Pmin by a period equal to the second time threshold DTMAX_SYS,

and in that in the fourth state (4) it also searches for a pressure signal second derivative maximum value Y2max_postdic within the eighth interval, the method also verifying that the maximum value

Y2max_diatosys determined in the first state (1) is not less than the value Y2max_postdic, so that:

- if the outcome of the verification is negative, the method returns to the first state (1) assuming as new starting point Pstart a point following the diastolic point Pdia and not following the dicrotic point Pdic, whereas
- if the outcome of the verification is positive, the method passes to the final state (7).

3. Method according to claim 1 or 2, characterised in that in the first state (1), the assumption of the points Pmin and Pmax as diastolic Pdia and systolic Psys points, respectively, depends on the outcome of the verification that the point Pmin precedes the point Pmax, so that:

- if the outcome of the verification is negative, the method returns to perform all the operations of the first state (1) assuming as new starting point Pstart a point not preceding Pmin, whereas
- if the outcome of the verification is positive, the point Pmin is assumed as diastolic point Pdia and the point Pmax is assumed as systolic point Psys and the method passes to the following second state (2).

4. Method according to any one of the preceding claims, characterised in that the finite state machine according to which it operates comprises a fifth state (5), the method passing from the fourth state (4) to the final state (7) by preliminarily passing to the fifth state (5),

wherein the method determines a pressure signal point P3 corresponding to the instant t3 wherein the pressure signal second derivative assumes the absolute minimum value Y2min_systodic within a ninth interval not exceeding the interval going from the systolic point Psys up to the dicrotic point Pdic, the method then passing to the final state (7) wherein it is apt to give the point P3.

5. Method according to claim 4, characterised in that said ninth interval goes from the instant which is intermediate within the interval included between the systolic point Psys and the dicrotic point Pdic

$$tsys + (tdic\text{-}tsys)/2$$

up to the instant of the dicrotic point Pdic

$$tdic,$$

where tsys is the instant corresponding to the systolic point Psys and tdic is the instant corresponding to the dicrotic point Pdic.

6. Method according to claim 4 or 5, characterised in that in the fourth state (4) the method verifies whether the pressure signal has been detected in an aorta, so that:

- if the outcome of the verification is positive, the method passes to the final state (7), whereas
- if the outcome of the verification is negative, the method passes to the fifth state (5).

7. Method according to any one of the preceding claims, characterised in that the finite state machine according to which it operates comprises a sixth state (6), at which the method arrives in the case

when in the third state (3) it has verified that the pressure signal presents a hump with downward concavity within the sixth time interval, the method arriving at the sixth state (6) after the fourth state (4) before passing to the final state (7), in the sixth state (6) the method searching in said sixth time interval for the relative maximum point P4 after the dicrotic point Pdic, i.e. the hump apex, the method then passing to the final state (7) wherein it is apt to give the point P4.

8. Method according to claim 7, characterised in that in the sixth state (6) the method also searches for a pressure signal relative minimum point Pend within a tenth interval not exceeding the interval going from the dicrotic point Pdic up to the point Ptermination distant from the dicrotic point Pdic by a sixth time threshold DENDPOSTDIC, the method being apt to give in the final state (7) the point Pend in the case when this has been determined in the sixth state (6).

9. Method according to claim 8, characterised in that the method searches for the point Pend after having determined the point P4 and in that said tenth interval goes from the point P4 up to the point Ptermination.

10. Method according to claim 8 or 9, characterised in that the sixth time threshold DENDPOSTDIC is not longer than 150 milliseconds.

11. Method according to any one of the claims from 7 to 10, when dependant upon claim 4, characterised in that the method arrives at the sixth state (6) starting from the fifth state (5).

12. Method according to any one of the preceding claims, characterised in that in the first state (1) it searches for the first point Pdec following the starting point Pstart belonging to a pressure signal decreasing phase, in that the first time interval goes from the first decreasing point Pdec up to the point distant from the determined minimum value Pmin by a first time threshold DTMIN_SYS, and in that the second time interval goes from the first decreasing point Pdec up to the point distant from the determined minimum value Pmin by a second time threshold DTMAX_SYS.

13. Method according to claim 12, characterised in that the third and the four time intervals go from the first decreasing point Pdec up to the point distant from the determined minimum value Pmin by a second time threshold DTMAX_SYS.

14. Method according to any one of the claims from 1 to 12, characterised in that the third and the four time intervals go from the determined minimum value Pmin up to the point distant from the determined minimum value Pmin by a second time threshold DTMAX_SYS.

15. Method according to any one of the claims from 1 to 12, characterised in that the third and the four time intervals go from the determined minimum value Pmin up to the determined maximum value Pmax.

16. Method according to any one of the preceding claims, characterised in that in the second state (2) it searches for the point Pinflection by searching for the pressure signal first derivative absolute

minimum value Y1min_postsys within the fifth time interval, assuming the pressure signal point wherein the first derivative thereof assumes the absolute minimum value Y1min_postsys as inflection point Pinflection.

17. Method according to any one of the preceding claims, characterised in that in the third state (3) it verifies whether in the sixth time interval the pressure signal presents a hump with downward concavity by searching for the pressure signal first derivative absolute maximum value Y1max_postsys and by verifying that this value Y1max_postsys is positive, whereby the pressure signal presents said hump in the case when the value Y1max_postsys is positive.

18. Method according to any one of the preceding claims, characterised in that in the third state (3) it searches within the seventh time interval for the pressure curve first relative minimum by searching for the instant wherein the pressure signal first derivative assumes the value of zero within said seventh time interval.

19. Method according to any one of the preceding claims, characterised in that, in the fourth state (4), the search for the first derivative maximum value Y1max_postdic and the second derivative maximum value Y2max_postdic of the pressure signal within the eighth interval, and the verification that both are not larger than the maximum values Y1max_postdia and Y2max_diatosys determined in the first state (1), are carried out only in the case when in the third state (3) the method has verified that the pressure signal presents a hump with

downward concavity within the sixth time interval.

20. Method according to any one of the preceding claims, characterised in that, when it returns from the fourth state (4) to the first state (1), the method assumes the point immediately preceding the determined dicrotic point Pdic as new starting point Pstart.

21. Method according to any one of the preceding claims, characterised in that the first time threshold DTMIN_SYS is not longer than 200 milliseconds.

22. Method according to claim 21, characterised in that the first time threshold DTMIN_SYS is not longer than 150 milliseconds.

23. Method according to any one of the preceding claims, characterised in that the second time threshold DTMAX_SYS is not longer than 380 milliseconds.

24. Method according to claim 23, characterised in that the second time threshold DTMAX_SYS is not longer than 350 milliseconds.

25. Method according to any one of the preceding claims, characterised in that the third time threshold DTMAX_MINY1_SYS is not longer than 250 milliseconds.

26. Method according to claim 25, characterised in that the third time threshold DTMAX_MINY1_SYS is not longer than 200 milliseconds.

27. Method according to any one of the preceding claims, characterised in that the fourth time threshold DTMAX_SYS2Y1DIC is not

longer than 250 milliseconds.

28. Method according to claim 27, characterised in that the fourth time threshold DTMAX_SYS2Y1DIC is not longer than 200 milliseconds.

29. Method according to any one of the preceding claims, characterised in that the fifth time threshold DPOSTDIC is not longer than 200 milliseconds.

30. Method according to claim 29, characterised in that the fifth time threshold DPOSTDIC is not longer than 150 milliseconds.

31. Method according to any one of the preceding claims, characterised in that the pressure signal is sampled at a frequency of 1 kHz.

32. Method according to any one of the claims from 1 a 10, characterised in that from the final state (7) it returns to iteratively perform the first state (1) by assuming a point following the dicrotic point Pdic as new starting point Pstart.

33. Method according to claim 32, when depending upon any one of claims from 1 to 7, characterised in that from the final state (7) it returns to iteratively perform the first state (1) by assuming a point following the dicrotic point Pdic and distant from this by a seventh time threshold DNEW as new starting point Pstart.

34. Method according to claim 33, characterised in that the seventh time threshold DNEW is not shorter than 1 millisecond and not longer than 150 milliseconds.

35. Method according to claim 32, when depending upon any one of claims from 8 to 10, characterised in that, in the case when in the sixth state (6) the point Pend has been determined, from the final state (7) the method returns to iteratively perform the first state (1) by assuming a point following the dicrotic point Pdic and preceding the point Pend as new starting point Pstart.

36. Method according to claim 35, characterised in that, in the case when in the sixth state (6) the point Pend has been determined, from the final state (7) the method returns to iteratively perform the first state (1) by assuming the point immediately preceding the point Pend as new starting point Pstart.

37. Method according to claim 32, when depending upon any one of claims from 8 to 10, characterised in that, in the case when in the sixth state (6) the point Pend has not been determined, from the final state (7) the method returns to iteratively perform the first state (1) by assuming a point following the dicrotic point Pdic and not following the point Ptermination as new starting point Pstart.

38. Method according to claim 37, characterised in that, in the case when in the sixth state (6) the point Pend has not been determined, from the final state (7) the method returns to iteratively perform the first state (1) by assuming the point immediately preceding the point Ptermination as new starting point Pstart.

39. Computer, comprising input and/or output interface means, memorising means, and processing means, characterised in that it is apt

to perform the automated method for discriminating the cardiac beat according to any one of the preceding claims 1-38.

40. Apparatus for detecting and analysing the blood pressure, comprising a computer and blood pressure detecting means, characterised in that said computer is the computer according to claim 39.

41. Computer program characterised in that it comprises code means adapted to execute, when running on a computer, the automated method for discriminating the cardiac beat according to any one of the preceding claims 1-38.

42. Memory medium, readable by a computer, storing a program, characterised in that the program is the computer program according to claim 41.